Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2008		**00-00-2008 to 00-00-2008**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Guest editorial: Cryospheric science and engineering	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **US Army ERDC Cold Regions Research and Engineering Lab,Terrestrial and Cryospheric Science Branch,72 Lyme Road,Hanover,NH,03755**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**2**	

Available online at www.sciencedirect.com
ScienceDirect
Cold Regions Science and Technology 52 (2008) 99–100
cold regions science and technology
www.elsevier.com/locate/coldregions

Editorial

Guest editorial: Cryospheric science and engineering

Keywords: Cold regions; Snow; Ice; Polar science; Polar engineering; Cryosphere; Cryospheric science; Cryospheric engineering; Sea ice; Robot; Ice core; Soil freeze–thaw

This Special Issue of Cold Regions Science and Technology contains a sampling of papers that were presented at the Cryospheric Science and Engineering Symposium held at the U.S. Army ERDC Cold Regions Research and Engineering Lab in Hanover, NH on 19 October 2006. The Symposium brought together cold regions engineers and scientists to share results on topics spanning many cold regions issues. Some of the topics have been important endeavors for many decades. Other topics are new areas arising from innovations in sensing and technology to address issues driven by climate change and/or the impact of human activity on the environment.

The most detailed naturally-archived records of environment and climate are found in ice cores drilled in polar and high-altitude regions. How did ice coring science get its start? The Langway paper provides a description of the IGY-era activities and international development of the early polar ice cores.

Snow covers the earth's surface extensively both in the polar regions and during winter in temperate areas, and its presence has a significant impact on human activity and on modern technologies. Marshall and Koh provide an overview of frequency modulated continuous wave radars used for sensing of snow properties. This paper discusses the development and the diverse applications of these radars by snow scientists to investigate snow properties on a variety of scales. In the acoustic domain, Albert et al. describe the impact of a snow cover on atmospheric acoustic wave propagation and the impact on acoustic sensors. They also describe the use of the acoustic signal in determining properties such as an integrated snow depth over tens of meters laterally along the wave propagation path. Snowfall also impacts life in the near-surface soil. In controlled outdoor testing, Reynolds and Ringelberg use molecular-based taxonomic methods to sample indigenous and introduced microbial populations at the soil surface and under a snow cover through the winter. Some species were found to increase significantly under a snow cover, while others survived through the winter in endospore state.

All-season terrain mobility models are used by the Army and others to predict the influence of changing weather, including snow conditions, on trafficability. Melloh et al. describe a novel shaped-solution mathematical technique that provides for continuous mapping of snow properties, including depth, for a variety of ground covers, elevations, and terrain slopes. When employed in dynamic models driven by time-varying weather, this technique offers a new means for obtaining realistic solutions in a computationally fast manner. Over-snow traverses have long been used for scientific investigations in the polar regions, yet only very recent developments in cold regions engineering have made traversing attractive as an alternative to aircraft for hauling heavy cargo long distances across Antarctica and Greenland. Weale and Lever report on their innovations in cold regions engineering that make traversing a mode of choice for NSF transport of fuel to the South Pole Station. Making ground-based measurements on the polar ice sheets is an expensive activity requiring extensive logistics and safety planning for humans on expeditions. Lever and Ray document the development of a polar robot that generates its own energy while en route (from sunlight) and will be able to make scientific measurements while traveling under its own power for months over the polar ice sheets.

Freezing and thawing of soils can radically change soil strength in very short periods of time, resulting in problems for vehicle movement. Shoop et al. present a material model for thawing soil that was validated from extensive test data for large strains on thaw weakened soil. They illustrate the use of the validated model in finite element simulations of a rolling wheel on paved and unpaved roads subject under freeze–thaw layering.

Sea ice is a complex system of pieces that are in non-rigid continual motion due to forcing by winds and ocean

0165-232X/$ - see front matter
doi:10.1016/j.coldregions.2007.11.002

waves. Thomas et al. present a method for rendering high resolution motion fields of ice, development of flow and fracture patterns using synthetic aperture radar images, facilitating understanding for science applications and for ship navigation.

Freezing and thermal cycling impact many engineered systems in applications on the Earth and beyond. Ferrick and others present results of investigations to determine the reduction in adhesion that resulted when ice phobic coatings were applied to test coupons simulating the surface of the Space Shuttle. In controlled testing they discovered the coatings, materials, application processes, and material properties that most impact adhesion for this situation. Freezing also impacts application and effectiveness of decontamination procedures for chemical and biological agents. Reynolds and others conducted laboratory studies to investigate the efficacy of an emerging decontamination solution against nerve agents. While freezing limited application of the standard formula, they developed an alternative formula that was as effective as the original but with good performance under subfreezing conditions. Continual, very cold conditions at the South Pole station demand structures which limit the infiltration of cold air into the buildings. Phetteplace and Weale present infrared imaging of the South Pole station showing locations of infiltration, and they also modeled heat transfer within a wall section to determine extent of freeze/thaw cycling of moisture in the walls that could lead to delamination of the wall material.

Impacts of cold processes affect natural and human activity in the polar regions, temperate regions, and in space. The results in this volume represent a snapshot of some of the issues and solutions. While the applications of science and engineering evolve over time, the need for cold regions science and engineering research continues to be as important today as it has been in the past. We wish to thank the authors for their excellent contributions, and we also thank the reviewers, who provided thorough, helpful, and very timely reviews. We also thank Chief Editor, Garry Timco, for his help and guidance through the publication process.

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8 August 2007